WASHINGTON
SCIENCE TRENDS

HIGHLIGHTS

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* POLARIS PROGRAM PLANS

The U. S. Navy expects to spend a total of $8.645 billion for its planned 45-submarine Polaris ICBM program, according to new official estimates. This includes almost $2 billion for weapon system development from the beginning of the program in 1955, but does not include proposed deployment of Polaris missiles on surface ships.

Under Navy plans awaiting final Defense Department approval the Cruiser U.S.S. Columbus, now undergoing coversion to a Talos-equipped Guided Missile Cruiser status at Puget Sound, Washington, would probably be the first Navy surface combat ship to carry the Polaris.

The Navy has advised Congress that there are "no hidden costs" in the $8.645 billion estimate which is based on:

ø Weapon system research, test, development and production for the missile, fire control, navigation, communication, and launching for a 1,500-nautical mile system.

ø Construction of submarines, installing equipment and checking out the operation of the submarine-weapon system.

ø Maintenance and operational training of Navy personnel.

ø Constructing submarine tenders, equipping them, and verifying their suitable operability.

ø Construction and equipping of the overall system production facilities including buildings, production and inspection tooling, maintenance facilities, etc.

ø Necessary support facilities such as the Naval Weapons annex missile-outloading facility, crew-team trainers, special communications facilities, etc.

ø Pay of personnel and material required to manage the overall Fleet Ballistic Missile system.

ø Manufacture, checkout and assembly of 16 missiles for each of the 45 submarines.

ø Manufacture of spare sets of missiles for the submarines for support operations.

ø Spare parts for the entire system plus setting up issuing stations.

ø Tools and equipment to provide weapons system overhaul capability to Navy Yards.

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POLARIS PROGRAM PLANS (Continued)

The 45 ship program assumes procurement of 1,005 missiles, for a cost per missile of $8.6 million. Subtracting replacements, spares and R&D missiles each of the 16 missiles installed in a 45 ship fleet would cost some $12 million including the costs previously outlined.

If the costs to develop and bring into operation the first nine Polaris weapon systems are subtracted the cost per missile in each tube for the remaining 36 submarines is $8.8 million.

The Navy makes a point of emphasizing that the system is "conservatively funded." Prorated cost for a 45-boat capability over a useful life of 15 years or more is estimated at $1 billion per year. This includes missile replacement every five years; R&D for longer-range missiles and future changes; replacement of submarines at the end of their useful life and normal operating and support expenses.

* Surface Ship Program

ø Cruisers -- The Navy estimates that the U.S.S. Columbus, scheduled to be commissioned as a Guided Missile Cruiser in December, 1961, could be converted to a Polaris system within an additional eight months at a cost of $49 million. This includes an expected saving in time due to the fact that the ship is currently being converted. Subsequent cruiser conversions would cost $37 million and would take 12 months. A crew of 45, including 4 officers, would be required for Polaris operations.

ø Heavy Cruisers (Reserve Fleet Ships) -- The Navy has told the Defense Department that conversion of the first reserve Heavy Cruiser would take 24 months and cost $186 million. Subsequent ships would be converted in about the same time period, but at a cost of $155 million. Such ships require 1,030 enlisted men and officers. Polaris operations would require 50 personnel, including 5 officers.

ø Merchant Ships (Victory Type) -- The Navy believes it would take 24 months to equip a merchant ship with the Polaris system. The first such conversion would cost $76 million, with the cost dropping to $58 million for follow-ons. It is estimated that such ships would be manned by 200 enlisted men and officers. Polaris operations would include 60 personnel, including 6 officers.

* Outlook -- Congress has been a vigorous supporter of the Fleet Ballistic Missile or Polaris submarine program, but has expressed only a passing interest in surface ship deployment. The Navy makes the point that Polaris surface ships would provide additional ICBM mobility and would provide a more "visible" deterrent -- meaning simply that the presence of such ships might be more effective under certain circumstances than submarines. Before its pre-Convention recess Congress appropriated approximately $1.3 billion for the entire Fleet Ballistic Missile program, about $2 million more than the Administration requested. But it is still uncertain whether these additional funds will be released by the Administration.

Interservice competition also plays an important role, with the Air Force and the Navy now vying for funds and missions in the ballistic missile deterrent and retaliation field. Air Force spokesmen argue that the upcoming Minuteman ICBM will be far less expensive than a shipborne Polaris. Navy spokesmen reply that this weapon would, however, be more vulnerable. The Air Force replies that more Minuteman missiles, in protected silos or on railroad cars, would survive an enemy attack.

* SUPERSONIC AIRCRAFT

The technical staff of the Langley (Va.) Research Center, National Aeronautics and Space Administration, has completed a comprehensive survey of the state of the art in the field of supersonic transports.

Their report, which spotlights the many problems involved, calls for a "vigorous effort on all fronts" if the U. S. is to achieve a supersonic transport capability at the earliest practicable date.

Here, for reference and planning, is a summary of their findings:

ø Aircraft Performance: With regard to performance, the state of the art appears sufficiently advanced to permit the design of an airplane at least marginally capable of performing the supersonic transport mission (3,500 nautical miles). Most designs proposed thus far, however, appear to have serious shortcomings with regard to off-design performance and operating flexibility. Further changes to both the basic airframe and engine configurations appear desirable. Also needed is a system of flight controls and communications sufficient to permit the airplane to fly in an optimum manner at all times.

ø Noise: The higher thrust-to-weight ratios of supersonic transports result in potential noise problems at take-off because of increased noise power at the source. High temperature afterburning at take-off probably cannot be tolerated; however, the development of turbofan engines should relieve the take-off noise problem. Relative to the sonic boom, there appears to be no problem associated with the high-altitude cruise portion of the flight. The climb and letdown phases are critical, however, and supersonic flight may necessarily be restricted to altitudes above 35,000 feet. This poses a serious airframe and engine matching problem.

ø Structures and Materials: Aircraft structural design and materials selection are critically dependent upon cruise Mach number. A life of 30,000 hours is generally considered as a minimum goal and most of this life will be spent at design temperature. Because of long exposure to design temperature, the use of aluminum-alloy construction is limited to temperatures somewhat below 300° F. At higher speeds, stainless steel or titanium alloy will be required. The use of sandwich construction can result in weight savings over conventional skin-stringer construction but at substantially increased cost. A critical problem area is expected to be fatigue (particularly sonic fatigue) at elevated temperatures. Research efforts devoted to evaluation of its significance and understanding are needed.

ø Structural Loads: The design of the supersonic transport will encompass loading conditions more severe than present subsonic transports. Areas needing evaluation and research are those associated with the unknown gust spectrums at high altitudes, gust response characteristics of supersonic configurations, the inability to slow down rapidly, the problem of increased cabin pressure differential, and the higher ground loads resulting from possibly increased landing and take-off speeds.

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ø Handling Qualities: Supersonic aircraft are characterized by an increase in longitudinal stability and a decrease in directional stability in going from subsonic to supersonic speeds. These characteristics, combined with the high relative density and greatly differing mass distributions, produce handling qualities significantly different from present jet transports. As a result, automatic damping about all three axes will probably be required. There exists a critical need for development of configurations with fail-safe characteristics such that in emergency they can be flown on manual control alone.

ø Runway Requirements: The take-off and landing speeds for fixed geometry supersonic transports tend to be higher than current jet transports, but runway requirements will be within the limits of international airports. Inasmuch as present jet aircraft are considered already marginal relative to take-off and landing, basic changes in airframe and engine may be required to provide any significant improvement.

ø Traffic Control and Operations: The supersonic transport must follow carefully prescribed climb, cruise, and letdown procedures. In some respects, this airplane is like a projectile, for once launched it must proceed along a precisely controlled flight path with little or no delays and with a large degree of dependence on automatic flight control and stabilization systems. There must be rapid automatic traffic control over the entire route. The capability of the pilot to assume safe manual control is questionable. The problem of fuel reserves is extremely critical, for present requirements can lead to reserve fuel weights greater than the payload.

ø Variable Geometry Transport Aircraft: Large wing sweep angles and low aspect ratios needed to achieve supersonic performance are not conducive to good low-speed characteristics associated with take-off, subsonic climb, holding in the traffic pattern, and landing. The use of variable geometry appears to have an aerodynamic potential such that savings in fuel reserves alone may more than compensate for increased structural weight. The potential advantages of the more sophisticated forms of variable geometry - such as variable sweep - are so great that their serious consideration for supersonic transports is warranted.

ø Airframe-engine Matching: The problem of airframe-engine match in a supersonic transport is critical because of the wide range of thrust requirements to be met and the need for high efficiency in off-design operation. The use of wing variable geometry can do much to relieve the engine match problem and to improve the off-design performance and operating flexibility. Performance analyses, however, indicate a strong need for a new engine, probably of the turbofan type, to be designed specifically for supersonic transport operation. Such an engine should have high take-off thrust at low noise levels, a large thrust margin for transonic acceleration, and high subsonic (off design) efficiency as well as good performance in the design cruise condition.

(Report Available. 91 Pages. Single Copies Free. Write National Aeronautics and Space Administration, 1520 H Street, N. W., Washington 25, D. C. for NASA TN D-243)

RESEARCH CHECKLIST

( ) ELECTROREFINING BERYLLIUM SCRAP: Researchers for the U. S. Bureau of Mines believe that their experiments in electrorefining beryllium scrap offer an encouraging route for the possible production of high-purity metal. Beads of beryllium are used as an anode in this process and are placed in the bottom of a special air-free electrorefining cell, of the type devised by the Bureau to refine titanium. Molten salts of potassium, lithium and beryllium serve as the electrolyte. Crystals of the near-pure beryllium are formed on the cathode much as rock candy builds up on a string.

(Report Available. Single Copies Free. Write Publications-Distribution Section, U. S. Bureau of Mines, 4800 Forbes Avenue, Pittsburgh 13, Pa. for Report of Investigations No. 5581)

( ) AIRCRAFT THUNDERSTORM HAZARDS: Experimental work for the National Aeronautics and Space Administration indicates that external thunderstorm charge fields pose an unsuspected hazard in possible ignition of aircraft fuel vapors. Previous studies had shown that direct lightning stroke currents could burn holes in fuel tank walls. The latest studies carry a plea for immediate consideration for development and use of protective measures for fuel vents from lightning and streamer hazards. The most promising approaches are said to be the use of flame arresters and the development of special vents.

(Report Available. 12 Pages. Single Copies Free. Write National Aeronautics and Space Administration, Attn: CODE BID, 1520 H Street, N. W., Washington 25, D. C. for TN -d-440)

( ) MODIFIED RECORDING POTENTIOMETER: Researchers at the Atomic Energy Commission's Savannah River Laboratory, Aiken, South Carolina have successfully modified a standard potentiometer to make it a multi-range instrument adaptable to many general laboratory uses. The instruments are in general use to record data that vary with time, but it was found that each laboratory situation required some modification of the measuring circuit. In the new version, the span resistor is moved to a point in the circuit at which high value resistors can be switched without regard to small contact resistance changes. The amplifier is shunted on each range to provide a constant sensitivity.

(Details Available. 19 Pages. 75 Cents. Write OTS, U. S. Department of Commerce, Washington 25, D. C. for AEC R&D Report DP -441)

( ) ELECTRIC ARC FURNACE: An electric arc said to be capable of generating temperatures up to 27,000° F. is currently being tested at the U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md. The arc consists basically of two electrodes surrounded by a plastic chamber. The arc is drawn between a rod-shaped anode and a doughnut-shaped cathode through which the hot plasma passes. A stream of water, whirling around the electrodes, forms a hollow core of vortex which restricts the diameter and thus intensifies the arc. The water also furnishes material to be heated and discharged through the hollow cathode as plasma.

(Equipment designed and built by Chicago Midway Laboratories, a non-profit organization associated with the University of Chicago.)

PUBLICATION CHECKLIST

( ) DIAMOND DRILLING, the first glossary ever prepared for the American diamond drilling industry, defining about 5,000 words and symbols of interest in a number of professional and industrial fields. 35 Cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. for Bureau of Mines Bulletin No. 583)

( ) TREASURY DEPARTMENT PATENTS, a Congressional report calling for revisions in patent policies of the Treasury Department and related industries. 93 Pages. Single Copies Free. (Write Subcommittee on Patents, Committee on the Judiciary, U. S. Senate, Washington 25, D. C. for Patent Practices of the Department of the Treasury)

( ) CALIBRATION OF SPECTROMETERS, a monograph on the Vibration-Rotation Structure in Absorption Bands for the Calibration of Spectrometers in the infrared region. The absorption bands of common gases were remeasured and tabulated as an aid to laboratories engaged in this type of study. 20 Pages. 20 Cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. for National Bureau of Standards Monograph No. 16)

( ) OCEANOGRAPHIC RESEARCH FOR DEFENSE, another chapter in a report in progress calling for additional Federal expenditures in the field of oceanography. This work covers Navy uses for oceanographic information. 15 Pages. Single Copies Free. (Write Printing and Publishing Office, National Academy of Sciences, Washington 25, D. C. for Oceanography 1960-1970, Chapter IV)

( ) RUBBER-PROCESSING CHEMICALS, a preliminary report by the U. S. Tariff Commission showing that total U. S. production of such chemicals amounted to 210 million pounds in 1959 -- a 24 percent increase in the course of one year. Single Copies Free. (Write Publications Office, U. S. Tariff Commission, Washington 25, D. C.)

( ) PHOTOTROPY, a review of the technical literature on this phenomenon for the period 1880 to 1955 and later. Contains reviews of books on photochemistry and lists phototropic solids and solutions. An explanation of the theory of phototropic phenomenon is also provided. Published Dec. 1959 and now available. 62 Pages. $1.75. (Write OTS, U. S. Department of Commerce, Washington 25, D. C. for PB 161 519)

( ) ARMY INDUSTRIAL ASSISTANCE, a much-too-brief pamphlet explaining the services available to contractors at the Army's Industrial Assistance and Procurement Office. Single Copies Free. (Write Industrial Assistance and Procurement Information Office, Office of the Deputy Chief of Staff for Logistics, Department of the Army, Room 732, Old Post Office Bldg., Washington 25, D. C. for D.A. Pamphlet 715-8)

( ) SUPERSONIC AIR TRANSPORTS, a Congressional report recommending speedy development of the B-70 bomber and the civilian supersonic transport program. 24 Pages. Single Copies Free. (Write Committee on Science and Astronautics, New House Office Bldg., Washington 25, D.C. for Report Serial g)

( ) SCIENTIFIC MANPOWER, a collection of papers presented at a Scientific Manpower conference in Chicago, Dec. 1959, emphasizing the need for additional higher education and training. 38 Pages. Single Copies Free. (Write National Science Foundation, Attn: Information Office, Washington 25, D. C. for Pub. NSF 60-34)